

**Land Use/Cover Change Analysis  
for the  
Lake Michigan Potential Damages Study,  
Wisconsin Coastal Zone**

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## **Land Use/Cover Change Analysis Report:**

### **I. Description of Work:**

In compliance with section 2 part C of the final scope of work for the Lake Michigan Potential Damages Study, a land use change analysis was conducted according to the methodology in the following section. The scope of work consists of the following components:

- Register the 1988 color infrared aerial photography to the same coordinate system as the 1999 Wisconsin Bluff Line Mapping dataset (UTM Zone 16, NAD 83).
- Register the 1988-90 land use inventory data for Ozaukee, Sheboygan, and Manitowoc counties to the same coordinate system as the 1988 color infrared aerial photography (UTM Zone 16, NAD 83).
- Update the land use inventory with the aid of the 1999 aerial photography using the IJC Land Use Classification system.
- Conduct a change analysis showing the change in land use classification for each polygon between the years 1988 and 1999.

### **II. Methodology:**

- 1) The 1988 current use inventory data for each county were converted from their original cad format (dln) to Arcview polygon shape file format. The text labels, International Joint Commission Classification (IJC), in the original files were added as attributes to each polygon in the new shapefiles.
- 2) The shapefiles were re-projected to UTM NAD 83 so that they could be overlaid on the 1999 and 1988 digital orthophoto mosaics for analysis.
- 3) The shapefiles were copied and renamed to 1999 current use inventory. The newly created copies were edited to reflect changes in land use/cover between 1988 and 1999.
- 4) An Arcview project was created that included the 1999 orthophotos, 1988 orthophotos, 1988 current use inventory shapefiles, and 1999 shapefiles to be edited.
- 5) The 1988 and 1999 orthophotos were visually compared to reveal areas of land use/cover change.
- 6) The 1999 shapefiles were edited via on screen digitizing to reflect the changes between the 1988 and 1999 orthophotos.
- 7) A buffer shapefile was created which included the 1000-meter coastal zone along the three county Lake Michigan coastline. The buffer shapefile was used to clip the 1988 and 1999 land use/cover shapefiles to the extent of the coastal zone.
- 8) The clipped shapefiles for each county were individually examined to check for human error. The Area and Perimeter fields were recalculated to reflect the changes between 1988 and 1999.
- 9) A new field was created to calculate the acres of each polygon by land use type.
- 10) Summary tables were created by land use/cover and exported to MS Excel for manipulation and analysis.
- 11) Four tables were created in MS Excel that depict the changes for each of the three counties and the study area in total.
- 12) Maps were created in Arcview that show the 1988-90 land use/cover, 1999 land use/cover, and the polygons that changed between the years 1988 and 1999.

### III. Special Considerations:

The polygon borders of the 1988-90 land use/cover inventory significantly varied from the observed boundaries on the 1988 orthophoto mosaics (up to 20 meters in some locations, but usually around 5 meters in many cases). In general, apparent land use change due to positional mis-registration of the original data layer would appear as long, narrow polygons, however polygons of this nature were not observed between the orthophoto and the 1988 data layer. The error could be due to the process by which the original data layer was created. This is speculation, on our part, because we did not know the methodology followed for the creation of the original dataset. Due to the nature of the error in the 1988 current use inventory (and carried forward in the 1999 analysis), conclusions should be limited to that of a general nature. The data from this analysis is not appropriate for site-specific conclusions.

In order to preserve the integrity of the analysis, the modifications to the 1999 shapefiles only reflect areas of observed change between the two years of orthophotos. If, in the opinion of the researcher, omissions were observed in the 1988 data, they were not corrected in the 1999 data. Some of the error in the original data could have been the result of a different interpretation of the IJC Classification definitions.

The 1988 current use inventory, 1988 orthophoto mosaics, and 1999 orthophoto mosaics all had different image extents. It was not possible to observe changes in those polygons of the 1988 current use inventory that did not overlay on the 1999 orthophotography. Also, the 1988 shapefile had data gaps within 1,000 meters of the coastline.

### IV. Recommendations for Future Projects:

Land Use and Land Cover change should be conducted as separate analyses. Land use data should be applied to the parcel level. Land Cover data could be gathered from a wide array of sources such as satellite imagery or aerial photography. In any case, if a change is to be accurately detected, the original source and the new source should use similar sensors or wavelengths.

### V. Analysis:

In all of the counties within the Lake Michigan coastal zone, there was an increase in built lands at the expense of agriculture and/or natural land. The degree of impact varied from county to county. For the entire study area, cropland was the predominant land use/cover in 1999 at 28%. However, single-family residential activities gained on cropland with an increase from 18.7% of the total land area in the coastal zone to 21.4%.

All of the commercial, office, and institutional growth between 1988 and 1999 occurred outside of central business districts where these districts were delineated in the 1988 dataset.

The noticeable increase in recreation was due to the conversion of land in Sheboygan County to a golf course. This represents a 200% growth of land utilized for recreational purposes in the county between 1988 and 1999.

Overall, urban and residential land use/cover increased by 15% in the coastal zone causing a decline of 6% in agricultural land use, open space, and natural cover. The increase in lands consumed for urban and residential activities were noticeably higher in Ozaukee and

Sheboygan counties at near 20%. Agricultural and natural lands decreased by 8 and 9% between 1988 and 1999 in these two counties as well. Manitowoc County had considerably less growth in urban and residential land use/cover at around 8% growth, with a decline in agriculture and natural areas of 3%. The following tables summarize the IJC classifications to support the above analysis.

#### **Manitowoc County:**

<b>Classification</b>	<b>1988 Acres</b>	<b>1999 Acres</b>	<b>Change in Acres</b>	<b>Percent Change</b>
Residential	2,081.3	2,315.8	234.5	11.27%
Commercial	468.4	489.8	21.4	4.57%
Industrial	379.2	425.5	46.3	12.21%
Utility/Trans	218.3	220.8	2.5	1.15%
Extractive	74.9	71.6	-3.3	-4.41%
Recreation	494.1	491.7	-2.4	-0.49%
Cemetery	15.0	15.0	0.0	0.00%
<b>Subtotal</b>	<b>3,731.2</b>	<b>4,030.2</b>	<b>299.0</b>	<b>8.01%</b>
Agriculture	4,526.6	4,347.4	-179.2	-3.96%
Natural Cover	4,949.8	4,829.9	-119.9	-2.42%
Water/Wetland	373.5	373.5	0.0	0.00%
<b>Subtotal</b>	<b>9,849.9</b>	<b>9,550.8</b>	<b>-299.1</b>	<b>-3.04%</b>

#### **Sheboygan County:**

<b>Classification</b>	<b>1988 Acres</b>	<b>1999 Acres</b>	<b>Change in Acres</b>	<b>Percent Change</b>
Residential	2,027.7	2,149.1	121.4	5.99%
Commercial	210.6	210.6	0.0	0.00%
Industrial	125.8	123.5	-2.3	-1.83%
Utility/Trans	368.9	368.9	0.0	0.00%
Extractive	0.0	0.0	0.0	0.00%
Recreation	230.1	694.8	464.7	201.96%
Cemetery	22.5	22.5	0.0	0.00%
<b>Subtotal</b>	<b>2,985.6</b>	<b>3,569.4</b>	<b>583.8</b>	<b>19.55%</b>
Agriculture	2,628.8	2,311.7	-317.1	-12.06%
Natural Cover	3,154.1	2,887.2	-266.9	-8.46%
Water/Wetland	825.3	825.3	0.0	0.00%
<b>Subtotal</b>	<b>6,608.2</b>	<b>6,024.2</b>	<b>-584.0</b>	<b>-8.84%</b>

## Ozaukee County:

<b>Classification</b>	<b>1988 Acres</b>	<b>1999 Acres</b>	<b>Change in Acres</b>	<b>Percent Change</b>
Residential	2,046.0	2,585.8	539.8	26.38%
Commercial	224.3	224.3	0.0	0.00%
Industrial	48.2	48.2	0.0	0.00%
Utility/Trans	163.0	165.2	2.2	1.35%
Extractive	6.3	15.0	8.7	138.10%
Recreation	273.1	273.1	0.0	0.00%
Cemetery	9.3	9.3	0.0	0.00%
<b>Subtotal</b>	<b>2,770.2</b>	<b>3,320.9</b>	<b>550.7</b>	<b>19.88%</b>
Agriculture	3,792.3	3,388.7	-403.6	-10.64%
Natural Cover	2,699.9	2,554.2	-145.7	-5.40%
Water/Wetland	99.5	100.3	0.8	0.80%
<b>Subtotal</b>	<b>6,591.7</b>	<b>6,043.2</b>	<b>-548.5</b>	<b>-8.32%</b>

## Entire 1,000 meter coastal zone:

<b>Classification</b>	<b>1988 Acres</b>	<b>1999 Acres</b>	<b>Change in Acres</b>	<b>Percent Change</b>
Residential	6,155.0	7,050.8	895.8	14.55%
Commercial	903.4	924.8	21.4	2.37%
Industrial	553.2	597.3	44.1	7.97%
Utility/Trans	750.1	754.8	4.7	0.63%
Extractive	81.2	86.6	5.4	6.65%
Recreation	997.3	1,459.7	462.4	46.37%
Cemetery	46.8	46.8	0.0	0.00%
<b>Subtotal</b>	<b>9,487.0</b>	<b>10,920.8</b>	<b>1,433.8</b>	<b>15.11%</b>
Agriculture	10,947.8	10,048.0	-899.8	-8.22%
Natural Cover	10,803.9	10,271.4	-532.5	-4.93%
Water/Wetland	1298.5	1299.3	0.8	0.06%
<b>Subtotal</b>	<b>23,050.2</b>	<b>21,618.7</b>	<b>-1,431.5</b>	<b>-6.21%</b>

\* For the purpose of the analysis, the categories used in the above tables consist of the following IJC classifications:

### Category:

Residential  
Commercial

Industrial  
Utility/Trans

Extractive  
Recreation

Cemetery

Agriculture

Natural Cover

### Classification:

Multi-family: Low-rise, Single Family, Mobile Home Park

Commercial, Central Business District, Retail Center, Other Retail Services,  
Institutional, Office

Industrial

Water Transportation, Road Transportation, Communication, Utility Line

Open Pit: Sand and Gravel

Recreation Open Use, Day-use Recreation

Cemetery

Cropland, Orchard Vineyard, Confined Feeding, Permanent Pasture, Other  
Agricultural

Upland Grass, Upland Shrub, Central Hardwoods/Oak, Aspen-Birch, Lowland  
Hardwoods, Pine, Other Upland Conifer, Lowland Conifers, Barren, Beach  
Riverbank, Sand Dune Exposed Bluff

Water/Wetland

River, Lake Pond, Reservoir, Shrub/Scrub Wetland, Emergent